

**NORTHROP**

Vice President - Research and Technology

DD/S&T# 36 74/73

November 19, 1973

*[Signature]*  
Memorandum for Members  
Net Technical Assessment Task Force  
Defense Science Board

*Herzfeld Panel*  
*Free*

I am enclosing rough drafts of two topics assigned to me by Dr. Herzfeld during our last meeting: (1) the Near-Far Problem in Secure Communication and (2) Possible Future Conflict Situations (Scenarios). These scenarios are being used by the Advanced Technology Panel of the ARPA/DNA Long Range Research and Development Program. They were amplified by the Panel from an outline provided by Professor Albert Wohlstetter for use in that Program.

*[Signature]*

D. A. Hicks

On file OSD release instructions apply.

Next 1 Page(s) In Document Exempt

interfering signal 40 db higher than the desired signal can degrade communications to an unacceptable level. In actual operational situations, one might expect user geometries in which interfering signals might range as high as 60 to 80 db higher than the desired signal, since transmitters operate at varying power levels, and more than two may be transmitting simultaneously in the same band of frequencies. Evidently the PN signal structure does not recommend itself as a solution to the "near-far" problem.

Consider next the different nature of the frequency hopping (FH) wave form. As shown schematically in figure 2, the transmitted signal "hops" in pseudo-random fashion back and forth among a large number of discrete frequencies (100 KHz apart), and for "fast frequency hopping" (FFH) at a high rate (100,000 times per second in this example); as the frequency shifts the phase of the signal is preserved, so that the FFH signal is fully coherent. While a desired signal occupies one frequency slot of the total transmission band, other interfering signals will with extremely high probability occupy different frequency slots, so that these interfering signals can be eliminated by a system of filters that is controlled by the known code of the desired signals.

Returning now to the earlier example (figure 1), we find that the assumed 100 MHz transmission band can be divided into 1000 discrete frequency slots ( $100 \times 10^6 / 100 \times 10^3$ ), each of adequate though narrow bandwidth for voice transmission, without interference between adjacent slots. With pseudo-random frequency hopping, the probability is only .001 that the interfering signal from user C will at a single instant occupy the same frequency in user A's receiver at the desired signal from user B. Due to the large number of hops per second, the bit error rate in the desired signal can be shown to be infinitesimal, less than  $10^{-30}$ . Thus the FFH wave form has easily solved the "near-far" problem in a situation where PRN using the same signal bandwidth could not.

In a much more effective and economical application of the fast frequency hopping technique, one could reduce the signal bandwidth by a factor of about 8 to 12.8 MHz, and the number of discrete frequencies to 128 (from 1000); and for higher quality voice transmission one could simultaneously increase the bit rate to 7200 HZ (from 2400). Then even with 10 interfering users, the bit error rate in the desired signal would be less than  $10^{-6}$ . While this is more than adequate for solving the near-far problem, the power needed by an enemy for broadband jamming has also been reduced by about 9 db. The latter effect is due solely to the reduction in signal bandwidth from 100 MHz to 12.8 MHz; hence the jamming resistance of a pseudo-random noise system would be equally degraded by that reduction in signal bandwidth.

In summary, it may be stated that the pseudo-random noise approach to spread-spectrum communication is inherently limited by "self-interference" from nearby friendly transmitters, whereas the fast frequency hopping approach results in hardware requirements determined by the anticipated enemy jamming environment.

-CONFLICT SITUATIONS

Examples to Provide Background Context  
and Rationale for Weapon Concepts

- A. Following repeat of Operation Sever exercises, USSR attacks NATO northern flank with simultaneous land, air, and amphibious invasion of Norway (north of Finland). NORWAY
- B. Iranian response to naval provocation by Iraq in Persian Gulf precipitates USSR armored invasion of Iran. USSR military forces occupy Iraq (allegedly to assist Iraq) with expectation of staying in Iraq whether or not they withdraw from Iran. IRAN
- C. Maintain credibility and political viability of NATO deterrent against the following possibility: Warsaw Pact exercise becomes full-scale armored invasion of the central front for limited-objective acquisition of the FRG lying to the east of the Rhine. (Assume SALT II and MBFR have previously reduced U.S. QRA assets and military personnel.) FRG
- D. Dispute over USSR basing privileges in Cuba precipitates: First, emplacement of Egyptian-like air defense system and extensive cruise missile installation; and later, installation of IRBM's. CUBA
- E. Sino/Soviet border conflict erupts. USSR augments naval forces in the Sea of Japan while massing land and air forces apparently for attack on the Lop Nor nuclear facilities. China launches preemptive invasion of the Maritime Territory and attempts to seize the Trans Siberian railway and the port of Vladivostok. U.S. provides covert assistance to Chinese operations. CHINA
- F. Japan has seized the four disputed Kuril Islands and Hokkaidō. At a later time USSR naval and amphibious exercises are carried out in the Sea of Okhotsk (with apparent intent to invade Japan's northern island of Hokkaidō). Simultaneously, N. Korea invades S. Korea. U.S. response by forces based in Japan provokes USSR to initiate actual invasion of Hokkaidō. U.S. moves to protect its assets based on Hokkaidō and to assist S. Korea. JAPAN
- G. N. Vietnamese attacks on U.S. facilities and forces in Thailand leads to "Linebacker III" B-52 raids on N. Vietnam for destruction of all military targets and industry supporting the military. VIETNAM

FOR OFFICIAL USE ONLY

EXAMPLEFORCE ENGAGEMENTSA. NORWAY

- 1) Massive delivery of air dropped non-nuclear weapons for interdiction of Soviet armor advances and destruction of amphibious landing operations.
- 2) Non-nuclear disablement of air base facilities supporting USSR air superiority in the theatre of operations.
- 3) Stop conventional attack and deter nuclear attack on U.S. CVA task force in N. Atlantic by providing nuclear anti-ship capability for U.S. ships and submarines.
- 4) Counter Soviet attack submarines by sanitizing critical ocean areas with mines.
- 5) As last resort, threaten and then strike Soviet ports or submarine pens with low-collateral damage.

B. IRAN

- 1) Massive delivery of air-dropped non-nuclear weapons for interdiction of Iraqi armored forces. Provide rapid augmentation of Iranian air defenses and anti-tank capability.
- 2) Air delivery of low-collateral damage nuclear barrier munitions to cut resupply routes.
- 3) Provide for viability of U.S. fleet operations in the Persian Gulf and Mediterranean through a) effective defense and through b) dispersed offensive capability.
- 4) USSR effects covert disablement of U.S. satellites to induce our withdrawal.

C. FRG

- 1) Massive delivery of air-dropped non-nuclear weapons for delay and destruction of Pact advancing armored forces. Weather ranges from low ceilings to general moderate rainfall.
- 2) Warsaw Pact aircraft attack high-value depots, bases, C<sup>3</sup>, air defense systems, and QRA assets with smart and area-type non-nuclear weapons.

- 3) From survivable basing remotely emplace "ADM's" for slowing of armored advance and resupply.
- 4) With low-collateral damage, attack Warsaw Pact airfields, command centers, LOC's, casernes, and nuclear storage sites. Provide effective means which accounts for target hardening and high-density defenses.
- 5) Threaten (with credibility) key segments of the Soviet industrial base with attack by precision-guided low-collateral damage nuclear weapons.
- 6) Soviet Union either a) withdraws forces and commences negotiation, or b) launches preemptive combined anti-FBM and ICBM attack on CONUS strategic military targets. U.S. launches its Triad forces. If 6 b), then:
- 7) U.S. employs its strategic reserve forces and survivable support systems (RECCE, NCA, C<sup>3</sup>) to establish a superior position vis a vis the Soviet Union. Survivable reserve general purpose forces then consolidate this position.

D. CUBA

- 1) Provide means for low-level close surveillance of potential missile installations.
- 2) Attack the IRBM's missile installations with high-kill probability.
- 3) Intercept leakage IRBM's.
- 4) Threaten discriminating attack against USSR ICBM silos if USSR does not immediately dismantle all forces in Cuba.
- 5) USSR destroys U.S. strategic satellites.

E. CHINA

- 1) Provide support without direct confrontation between USSR/US personnel. Operating from bases outside the PRC, U.S. provides covert interdiction of Soviet armored forces by stand-off delivery of mines and submunitions.
- 2) Remote emplacement of ADM's (covert).
- 3) USSR attacks U.S. fleet in Sea of Japan with nuclear missiles as firm warning to stay out of the Sino/Soviet conflict.

F. JAPAN

- 1) Attack N. Korean air forces based in caves.
- 2) Emplacement of barriers in mountainous border territory from remote launch positions further south. Consider late release of nuclear authority.
- 3) While avoiding direct confrontation with the USSR forces, provide weapon systems for Japanese use (or U.S. operation from Japanese soil) in blocking the invasion of Hokkaido.
- 4) U.S. assist Japan by massive emplacement of non-nuclear land and sea mines.
- 5) Submarine-launched missiles and air-surface missiles attack U.S. ships in Sea of Japan following MIG-25 surprise attack on E2C, 5-3, EC-121 aircraft.
- 6) U.S. threatens missile attack on Soviet ports and submarine bases supporting Soviet operations in the theatre.

G. VIETNAM

- 1) Provide major improvement in air defense suppression.
- 2) Utilize fighter-bomber and bomber aircraft for highly discriminating delivery of air-ground ordnance with improved features for accuracy, stand-off, and adverse weather.
- 3) Attack most heavily defended target complexes (including air bases) by means of long range unmanned weapons.

FOR OFFICIAL USE ONLY